Utilizing sonography to image fetal hands and determine its relationship with birth outcome measures.

A thesis
Presented in Partial Fulfillment of the Application for Graduation with Honors and Distinction in Radiologic Sciences and Therapy in the School of Allied Medical Professions of The Ohio State University

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2009

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ABSTRACT

Diagnostic Medical Sonography has been used for many years to screen fetuses for anatomical and structural abnormalities. In 2004, twenty percent of fetal deaths in the United States occurred as a consequence of congenital malformations, deformations, and chromosomal abnormalities. With the use of sonography, many of these conditions can be detected well before birth. Sonographers look for certain markers, such as an increased nuchal fold at the back of the neck, absent nasal bones, clubbed feet, and hand deformations that may indicate chromosomal abnormalities. Abnormalities of the hands and fingers can be indicative of Trisomies 13 and 18, as well as Down's syndrome, making imaging the hands extremely important. The research hypothesis was that a correlation exists between fetal hand positions, postures, and APGAR scores at birth. A secondary data analysis of 55 fetuses was designed to verify the proposed relationship between fetal hands and birth outcome measured by APGAR scores. Images were graded based upon whether the hands were open or closed and if they were positioned by the head, body, or legs. Results of the research disproved the research hypothesis as there was no significant correlation between hand posture and position and APGAR scores. Though it is important to use sonography to carefully scrutinize fetal hands for defects, determining posture and position may have limited utility for predicting fetal wellbeing prior to birth.

ACKNOWLEDGEMENT

I would like to express my gratitude to my research advisor Dr. Evans for his guidance and persistent help. He has provided assistance in numerous ways to make this project achievable.

I would also like to thank Pamela Foy for her expertise in fetal sonography. Her ability to provide me with resources to made this research possible.

I am also grateful for the help from Shawn Roll, as he provided me with instruction and guidance through the statistical analysis of my research project.

LIST OF FIGURES

TABLE OF CONTENTS

CHAPTER 1

PROBLEM STATEMENT

Screening techniques are needed to help in the prediction of healthy outcomes for infants in the United States. Diagnostic Medical Sonography (DMS) has been used for many years to screen the fetus for anatomical and structural anomalies. This research begins to explore the potential for utilizing DMS to screen the fetus and determine potential birth outcome. The use of fetal hand evaluation with DMS has been researched[1]; however, this research may have the translational impact to provide important information regarding viability. The impetus is to build on this preliminary work and extend it as a possible predictor of infant wellbeing at birth.

REVIEW OF LITERATURE

As reported by the Central Intelligence Agency World Factbook[2] the infant mortality rate for the United States in 2007 was 6.37 deaths for every 1000 births. Infant mortality is defined as death under 1 year of age. Compared with 221 other countries in the world, the United States ranks 180. Though this rate has dropped from 6.78 in 2004 and has decreased by more than 10% since 1995, this is still considered a vast problem for such a modernized country with endless technological improvements. Approximately two thirds of all infant deaths occur during the neonatal period, which is defined as birth through the 27th day of life. Much of the mortality in the past years has been due to the number of advanced maternal age and teenage pregnancies, which increase fetal risk. As reported in 2004, congenital malformations, deformations, and chromosomal abnormalities accounted for 20% of all infant deaths in the United States, while short gestation and low birth weight accounted for 17%[3].

Congenital malformations, deformations, and chromosomal abnormalities need not be a surprise at birth, however. With the use of DMS, it is possible to obtain several fetal measurements, which can indicate potential problems that may persist at birth. For example, a nuchal translucency (NT) measurement is now a major part of sonographic evaluations during the first trimester. This elevation of skin on the back of the fetal neck was first reported in the 19th century. Since then, DMS has made it easier to detect this translucent area that lies beneath the skin[4]. In a study conducted in Finland from 1993 to 1995, a total of 74 fetuses with a nuchal translucency measurement exceeding 3 millimeters underwent a chorionic-villus sampling or amniocentesis. Of those fetuses, 24% came back with an abnormal fetal karyotype indicating one of the following: Turner's syndrome, Trisomy 18, Trisomy 21, or aneuploidy, which is any abnormal number of chromosomes[5]. In a similar prospective study done in 1999, 53 fetuses with an increased nuchal translucency exceeding 4 millimeters received fetal karyotyping. Results showed that 28.3% (15 fetuses) had abnormal findings, with the majority of them having Down's syndrome[6]. In a cohort study performed in 1999, 50 fetuses with a known cardiac defect underwent DMS to obtain a nuchal translucency measurement. A total of 56% of those examined had a nuchal measurement above the 95th percentile, while 40% had above the 99th percentile. This study demonstrates that an increase in nuchal thickness at 10-14 weeks of gestation is associated with major abnormalities of the heart including Tetralogy of Fallot, hypoplastic left heart, and transposition of the great arteries[7]. Additional prospective research has found that an increased NT can identify 76.8% of fetuses with Trisomy 21. Furthermore, when this measurement is combined with maternal serum screening, the rate of finding Down's syndrome increases to 87%[8].

In addition to NT measurements, DMS can also be used to detect chromosomal abnormalities and fetal outcome in other ways. Absence of a fetal nasal bone between 11 and 14 gestational weeks was detected by sonography in 69% of fetuses with Trisomy 21. Trisomy 21 can also be linked with abnormal flow through the ductus venosus. Trisomies 13 and 18 have associative characteristics that can be detected by DMS as well, such as tachycardia and bradycardia, respectively[8]. Assessing amniotic fluid is also a useful way to predict fetal outcome. A cohort study carried out in 2003 found that obtaining an amniotic fluid index (AFI) measurement less than 5 centimeters in a pregnancy beyond full term can be associated with severe adverse outcomes at birth, including perinatal asphyxia and fetal distress leading to a cesarean section. Research indicates that lack of fluid can result in an APGAR score (See Appendix B) of less than 8 after 5 minutes[9]. It has been reported that a score between 8 and 10 indicates the best condition for the neonate[10].

Aside from the aforementioned anomalies listed, deformities of the hands and feet can also be indicators of chromosomal defects. The most common abnormality of the hands and feet, occurring in 5 of every 1000 births, is congenital clubfoot. Though this can be an isolated malformation, clubfoot can also be linked to specific syndromes. Abnormalities of the hands can be associated with particular chromosomal defects, as well. Fetuses with Trisomy 18 often have fingers that overlap and clenched hands, not allowing them to fully extend their fingers. Polydactyly, is many times seen with

Trisomy 13[11]. Furthermore, a missing or small middle phalanx of the fifth digit is associated with Down's syndrome. This anomaly, known as hypoplasia, occurs in 60% of the fetuses with Down's syndrome[12]. Though a diagnosis cannot be made exclusively with these markers, they all are good indicators of chromosomal abnormalities and will lead the sonographer and physician to further scrutinize the fetus for other problems that may be present upon birth.

Using DMS to image the hands of a fetus can be extremely helpful when trying to detect chromosomal defects. The purposes of the previously mentioned studies were to use sonography to document certain measurements, such as nuchal translucencies, structural defects, like polydactyly, and to possibly detect congenital malformations and fetal outcome.

Building on the earlier research conducted by Reiss et al[1], the next step in utilizing DMS of the upper extremity is to determine its relationship to fetal wellbeing. The proposed research seeks to prove or disprove the following research hypothesis:

> *A statistically significant correlation exists between the sonographic imaging of fetal hand positions and ultimate fetal wellbeing at birth.*

CHAPTER 2

METHODOLOGY

This study was a secondary data analysis of existing information that has been gathered by The Ohio State Medical Center's OB/GYN Department on infants that were retrospectively imaged with DMS and delivered at the OSU Medical Center. The data points that were specifically analyzed include the DMS images of fetal hands and the APGAR scores provided at birth. This was designed as a correlational study and considered such because it compares two or more different characteristics from the same group of subjects. This study was approved by the OSU International Review Board as exempt research.

POPULATION AND SAMPLE

A sample of 55 DMS fetal exams was reviewed from The Ohio State Medical Center OB/GYN 2-C Clinic's PACS system. The 55 exams contained initial sonographic anatomy ranging in gestational age from 15-37 weeks. Only exams of women that were delivered at The Ohio State Medical Center were reviewed. Only exams of women considered to be low risk and pregnant with a single fetus were included in the study. Only DMS exams that included detailed images of the fetal hands were included in the research study.

DESIGN

This secondary research was designed to explore the potential relationship between images of fetal hands and birth outcomes as measured by APGAR scores. Fetal

DMS exams which were completed in January 2008 were reviewed. Sonograms of fetal hands were reviewed by two sonographers and the grading was determined together. Only the first image of each hand was considered due to the constant movement of the fetus. The grading of fetal hand posture was either open or closed, which was coded as 1 for open hands or 2 for closed hands. Grading of fetal hand position was coded as either 1 for by the head, 2 for by the chest or abdomen, or 3 for by the legs. See Appendix A for examples of hand posture and position grading. The independent variable was a dichotomous nominal variable representative of fetal hand posture and position.

The dependent variable was the APGAR scores which were scored at 1 and 5 minutes and obtained for each infant delivered at The Ohio State Medical Center. The APGAR scores at the two time points are considered interval data. Following the completion of all data collection, an analysis was done to obtain the strength of association between the independent and dependent variable. The Chi-Square statistic was used to measure the strength of association since the independent variable is a dichotomous nominal variable and the dependent variable is interval data.

DATA AND INSTRUMENTATION

The data collected from each reviewed sonogram on the PACS system included the patient's name and medical record number; however, this was not recorded, as the data was kept de-identified to protect the patients' information. The only recorded data from the patient record was the date of the sonographic exam, fetal gestational age, and estimated date of confinement. The location of the fetal hands was recorded relative to their relationship in the image to the face, chest, abdomen, or lower extremities. Posture of the hands was recorded as either open or closed. To be considered open, the digits needed to be extended to view the 3 phalanges. The hand postures and positions were recorded on a tracking form that was kept in Dr. Evans' office for security reasons. The APGAR scores for each delivered infant were obtained from the Registered Nurse Labor and Delivery Summary which is maintained on the OSUMC computerized medical record. APGAR scores were obtained at 1 and 5 minutes of life and each were included in the data. The date of birth was also recorded. Again, all of this sensitive patient information was de-identified and all data collection forms were kept in Dr. Evans' office to maintain privacy and security. At the conclusion of the project, the data will continued to be stored in a locked file cabinet in Dr. Evans' office and destroyed in three years.

A total of 55 pairs of fetal hands were evaluated from the clinic's sample population which is representative of their low risk pregnant women. APGAR scores for only 45 of those same 55 fetuses were available.

The power analysis for this study was based on a sample size of 55 which should yield a moderate effect size with a power level of 0.7 and an alpha of 0.05. The results of this study are only representative of this sample of patients given the many threats to internal and external validity inherent in a correlational research study.

FACILITIES AND/OR RESOURCES AND EQUIPMENT UTILIZED

In order to collect all of the data for this secondary data analysis, access to PACS was required. The Labor and Delivery Summary provided by The OSUMC computerized medical record in order to obtain APGAR scores of each newborn. SPSS software was provided by the Radiologic Sciences and Therapy Division to facilitate the statistical analysis required.

CHAPTER 3

RESULTS

A total of 55 pairs of hands were graded according to position and posture. Of those 55 fetuses, only 45 delivered at The Ohio State University Medical Center. Therefore, only 45 APGAR scores were obtained to complete the correlation. The highest APGAR given was a 9, while the lowest was a 0 due to fetal death. Of the 45 right hands, 16 were open and 29 were closed. Twenty-seven right hands were seen by the face or head, while 12 were seen by the chest and only 6 by the legs. Of the 45 left hands 15 were open and 30 were closed. Twenty-five were seen by the head, 11 by the chest, and 9 down by the legs. See Appendix C, page 30 for a chart of results. A total of 23 fetuses exhibited bilateral hands in the same posture and position. At 1 minute 60% of the infants had an APGAR of 9, 26% had a score of 8, and 13% had 7 or below. At 5 minutes 93% had an APGAR of 9, 4% had a score of 8, and 2% had a score of 0.

The Chi-Square test was used to determine whether any correlation exists between the hands and the APGAR scores of the 45 delivered babies. The most interesting correlation was between the right hand posture and the 1 minute APGAR. The right hand posture at the 1 minute APGAR had a p-value of .125, while at 5 minutes p= .233. However, significance is demonstrated with a p-value that is less than .05, so this statistic cannot be reported.

When crossed with the APGAR score at 1 and 5 minutes, the left hand posture had a p-value of .598 and .448, respectively. As for position, the right hand had a p-value of .966 for the APGAR at 1 minute and .710 for 5 minutes. The left hand position showed similar results for the APGARS at 1 and 5 minutes, with p-values of .832 and .772, respectively. See Appendix C, page 30 for a chart of results.

DISCUSSION

This data analysis disproved the research hypothesis that a statistical significant correlation exists between this sample of fetal hand positions and postures and an infant's APGAR score. The right hand posture had the most interesting relationship although not reportable. Because no significance was found, this small study of an infant's APGAR score and well-being could not be related to the imaging of fetal hand position and posture. Perhaps more rigorous results could be obtained with a larger sample size, since only 45 pairs of hands were analyzed. Despite the results, imaging fetal hands throughout a pregnancy is still thought to be imperative because the sonographic depiction of fetal hands can relate chromosomal abnormalities, as discussed in previous studies.

The secondary data analysis performed above showed 66% of the fetal hands closed. It is extremely important to closely watch fetal movement to ensure the fingers fully extend at some point throughout the ultrasound exam. As discussed in previous studies and articles, clenched hands can be indicative of Trisomy 18. Hands should also be carefully imaged to rule out polydactyly, which could indicate Trisomy 13[11].

Although this was a small descriptive study that did not demonstrate appreciable results, a larger study that is prospective could be designed. A prospective study of this nature would involve recruiting patients in the 2nd trimester and gathering data with a defined scanning protocol. Because fetuses move their hands numerous times throughout an obstetrical sonogram, perhaps data should be gathered detailing how long the hands are in certain postures and positions. A data capture of at least 100 fetuses would be needed to provide the power and effect to ensure statistical rigor. With these additional suggestions to the study, a more rigorous set of result could be obtained.

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APPENDIX A

IMAGES OF FETAL HANDS

Figure 1A: Closed by the Body

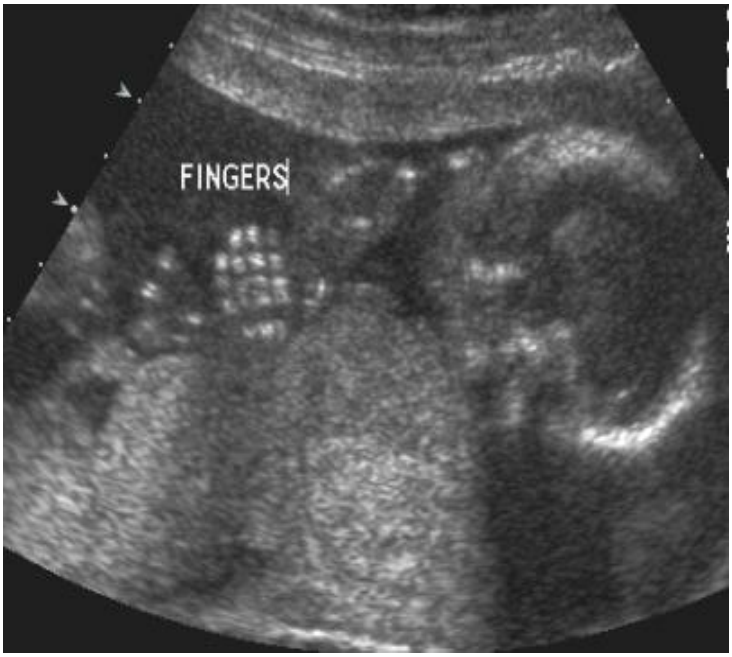

Figure 1B: Open by the Body

Figure 2A: Closed by the Head

Figure 2B: Open by the Head

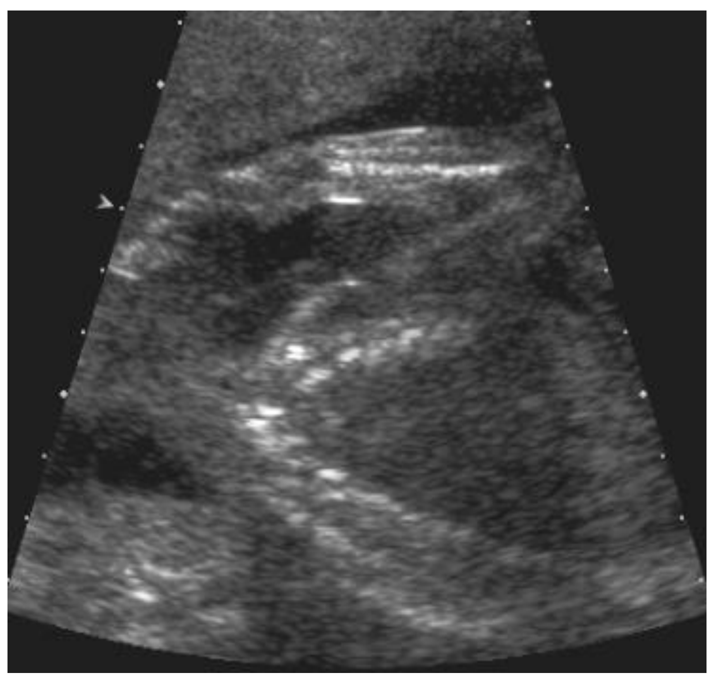

Figure 2C: Open by the Head

Figure 3A: Closed by the Legs

APPENDIX B

APGAR SCORING

	SIGN	0 POINTS	1 POINT	2 POINTS
A	ACTIVITY (MUSCLE TONE)	ABSENT	ARMS AND LEGS FLEXED	ACTIVE MOVEMENT
P	PULSE	ABSENT	BELOW 100 BPM	ABOVE 100 BPM
G	GRIMACE (REFLEX IRRITABILITY)	NO RESPONSE	GRIMACE	SNEEZE, COUGH, PULLS AWAY
A	APPEARANCE (SKIN COLOR)	BLUE-GRAY, PALE ALL OVER	NORMAL, EXCEPT FOR EXTREMITIES	NORMAL OVER ENTIRE BODY
R	RESPIRATION	ABSENT	SLOW, IRREGULAR	GOOD, CRYING

ACCORDING TO THE OHIO STATE UNIVERSITY MEDICAL CENTER WEBSITE*:

- A SCORE OF 7-10 IS CONSIDERED NORMAL
- A SCORE OF 4-6 INDICATES THE INFANT NEEDS SOME RESUSCITATION MEASURES AND CAREFUL MONITORING
- A SCORE OF 3 OR BELOW INDICATES THE INFANT NEEDS RESUSCITATION AND LIFESAVING TECHNIQUES.

*HTTP://MEDICALCENTER.OSU.EDU/PATIENTCARE/HEALTHCARE_SERVICES/PREGNANCY_CHILDBIRTH/LABORANDDELIVERY/CARE_BABY_DELIVERY/PAGES/INDEX.ASPX

APPENDIX C

STATISTICAL ANALYSIS

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
APGAR Score at 1 Minute * Right Hand Posture	45	100.0%	0	.0%	45	100.0%
APGAR Score at 1 Minute * Left Hand Posture	45	100.0%	0	.0%	45	100.0%
APGAR Score at 1 Minute * Right Hand Position	45	100.0%	0	.0%	45	100.0%
APGAR Score at 1 Minute * Left Hand Position	45	100.0%	0	.0%	45	100.0%
APGAR Score at 5 minutes * Right Hand Posture	45	100.0%	0	.0%	45	100.0%
APGAR Score at 5 minutes * Left Hand Posture	45	100.0%	0	.0%	45	100.0%
APGAR Score at 5 minutes * Right Hand Position	45	100.0%	0	.0%	45	100.0%
APGAR Score at 5 minutes * Left Hand Position	45	100.0%	0	.0%	45	100.0%

APGAR Score at 1 Minute * Right Hand Posture

Crosstab

			Right Hand Posture		Total
			Open	Closed	
APGAR Score at 1 Minute	0	Count	1	0	1
		% within Right Hand Posture	6.3%	.0%	2.2%
	1	Count	0	1	1
		% within Right Hand Posture	.0%	3.4%	2.2%
	5	Count	1	0	1
		% within Right Hand Posture	6.3%	.0%	2.2%
	7	Count	0	3	3
		% within Right Hand Posture	.0%	10.3%	6.7%
	8	Count	2	10	12
		% within Right Hand Posture	12.5%	34.5%	26.7%
	9	Count	12	15	27
		% within Right Hand Posture	75.0%	51.7%	60.0%
Total		Count	16	29	45
		% within Right Hand Posture	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.631[a]	5	.125
Likelihood Ratio	10.664	5	.058
Linear-by-Linear Association	.036	1	.849
N of Valid Cases	45		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .36.

APGAR Score at 1 Minute * Left Hand Posture

Crosstab

			Left Hand Posture		Total
			Open	Closed	
APGAR Score at 1 Minute	0	Count	0	1	1
		% within Left Hand Posture	.0%	3.3%	2.2%
	1	Count	0	1	1
		% within Left Hand Posture	.0%	3.3%	2.2%
	5	Count	0	1	1
		% within Left Hand Posture	.0%	3.3%	2.2%
	7	Count	0	3	3
		% within Left Hand Posture	.0%	10.0%	6.7%
	8	Count	4	8	12
		% within Left Hand Posture	26.7%	26.7%	26.7%
	9	Count	11	16	27
		% within Left Hand Posture	73.3%	53.3%	60.0%
Total		Count	15	30	45
		% within Left Hand Posture	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.667[a]	5	.598
Likelihood Ratio	5.511	5	.357
Linear-by-Linear Association	2.357	1	.125
N of Valid Cases	45		

a. 9 cells (75.0%) have expected count less than 5. The minimum expected count is .33.

APGAR Score at 1 Minute * Right Hand Position

Crosstab

			Right Hand Position			Total
			By the head	By the chest	Below the waist	
APGAR Score at 1 Minute	0	Count	1	0	0	1
		% within Right Hand Position	3.7%	.0%	.0%	2.2%
	1	Count	1	0	0	1
		% within Right Hand Position	3.7%	.0%	.0%	2.2%
	5	Count	1	0	0	1
		% within Right Hand Position	3.7%	.0%	.0%	2.2%
	7	Count	2	1	0	3
		% within Right Hand Position	7.4%	8.3%	.0%	6.7%
	8	Count	7	4	1	12
		% within Right Hand Position	25.9%	33.3%	16.7%	26.7%
	9	Count	15	7	5	27
		% within Right Hand Position	55.6%	58.3%	83.3%	60.0%
Total		Count	27	12	6	45
		% within Right Hand Position	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.542[a]	10	.966
Likelihood Ratio	4.965	10	.893
Linear-by-Linear Association	2.055	1	.152
N of Valid Cases	45		

a. 15 cells (83.3%) have expected count less than 5. The minimum expected count is .13.

APGAR Score at 1 Minute * Left Hand Position

Crosstab

			Left Hand Position			Total
			By the head	By the chest	Below the waist	
APGAR Score at 1 Minute	0	Count	1	0	0	1
		% within Left Hand Position	4.0%	.0%	.0%	2.2%
	1	Count	1	0	0	1
		% within Left Hand Position	4.0%	.0%	.0%	2.2%
	5	Count	1	0	0	1
		% within Left Hand Position	4.0%	.0%	.0%	2.2%
	7	Count	1	2	0	3
		% within Left Hand Position	4.0%	18.2%	.0%	6.7%
	8	Count	6	3	3	12
		% within Left Hand Position	24.0%	27.3%	33.3%	26.7%
	9	Count	15	6	6	27
		% within Left Hand Position	60.0%	54.5%	66.7%	60.0%
Total		Count	25	11	9	45
		% within Left Hand Position	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.794[a]	10	.832
Likelihood Ratio	6.848	10	.740
Linear-by-Linear Association	1.513	1	.219
N of Valid Cases	45		

a. 14 cells (77.8%) have expected count less than 5. The minimum expected count is .20.

APGAR Score at 5 minutes * Right Hand Posture

Crosstab

			Right Hand Posture		
			Open	Closed	Total
APGAR Score at 5 minutes	0	Count	1	0	1
		% within Right Hand Posture	6.3%	.0%	2.2%
	8	Count	0	2	2
		% within Right Hand Posture	.0%	6.9%	4.4%
	9	Count	15	27	42
		% within Right Hand Posture	93.8%	93.1%	93.3%
Total		Count	16	29	45
		% within Right Hand Posture	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.916[a]	2	.233
Likelihood Ratio	3.826	2	.148
Linear-by-Linear Association	1.376	1	.241
N of Valid Cases	45		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .36.

APGAR Score at 5 minutes * Left Hand Posture

Crosstab

			Left Hand Posture		Total
			Open	Closed	
APGAR Score at 5 minutes	0	Count	0	1	1
		% within Left Hand Posture	.0%	3.3%	2.2%
	8	Count	0	2	2
		% within Left Hand Posture	.0%	6.7%	4.4%
	9	Count	15	27	42
		% within Left Hand Posture	100.0%	90.0%	93.3%
Total		Count	15	30	45
		% within Left Hand Posture	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.607[a]	2	.448
Likelihood Ratio	2.539	2	.281
Linear-by-Linear Association	.737	1	.391
N of Valid Cases	45		

a. 4 cells (66.7%) have expected count less than 5. The minimum expected count is .33.

APGAR Score at 5 minutes * Right Hand Position

Crosstab

			Right Hand Position			Total
			By the head	By the chest	Below the waist	
APGAR Score at 5 minutes	0	Count	1	0	0	1
		% within Right Hand Position	3.7%	.0%	.0%	2.2%
	8	Count	2	0	0	2
		% within Right Hand Position	7.4%	.0%	.0%	4.4%
	9	Count	24	12	6	42
		% within Right Hand Position	88.9%	100.0%	100.0%	93.3%
Total		Count	27	12	6	45
		% within Right Hand Position	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.143[a]	4	.710
Likelihood Ratio	3.207	4	.524
Linear-by-Linear Association	.813	1	.367
N of Valid Cases	45		

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .13.

APGAR Score at 5 minutes * Left Hand Position

Crosstab

			Left Hand Position			
			By the head	By the chest	Below the waist	Total
APGAR Score at 5 minutes	0	Count	1	0	0	1
		% within Left Hand Position	4.0%	.0%	.0%	2.2%
	8	Count	1	1	0	2
		% within Left Hand Position	4.0%	9.1%	.0%	4.4%
	9	Count	23	10	9	42
		% within Left Hand Position	92.0%	90.9%	100.0%	93.3%
Total		Count	25	11	9	45
		% within Left Hand Position	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.800[a]	4	.772
Likelihood Ratio	2.450	4	.654
Linear-by-Linear Association	.717	1	.397
N of Valid Cases	45		

a. 6 cells (66.7%) have expected count less than 5. The minimum expected count is .20.

	Right	Left
Open	16	15
Closed	29	30
Head	27	25
Body	12	11
Legs	6	9

Hand grading results.

	APGAR 1	APGAR 5
Right Posture	.125	.233
Right Position	.966	.710
Left Posture	.598	.448
Left Position	.832	.772

P-values for associations between hand positions/postures and APGAR scores at 1 and 5 minutes. Significance is found with a p-value $< .05$.